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Fistularia commersonii (Rüppell, 1838) (Piscès: Fistulariidae): Length-weight relationship and condition factors from the Egyptian Mediterranean waters (West Alexandria)

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RESEARCH ARTICLE

Fistularia commersonii (Rüppell, 1838) (Piscès: Fistulariidae): Length−Weight Relationship and Condition Factors from the Egyptian Mediterranean Waters (West Alexandria)

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Abstract

Aim: **The present work deals with the length-weight relationship (LWR), Fulton's condition factor (kc) and the relative weight condition factor (kn) for females, males and pooled samples of bluespotted cornetfish, *Fistularia commersonii* in the Egyptian Mediterranean waters.**

Methods: **Between October 2017 and March 2019, a total of 101 kg and 746 individuals of *F. commersonii* were randomly collected each month from the commercial catch that was trawled from El-Hamam to Sidi-Kirayr, West of Alexandria.**

Results and conclusions: **For the whole samples, the total length of *F. commersonii* ranged between 24.1 cm TL and 107.5 cm TL (mean = 56.66 ± 15.740) and there was a variation in the total body weight (T.Wt) of 5 g to 1055 g (mean = 136.33 ± 135.418) and the gutted body weight (G.Wt) of 4 g to 856 g (mean = 124.03 ± 120.233). On total and gutted weights, the LWR equations were as follows: T.Wt = 0.0001 $L^{3.4314}$ (R^2 = 0.9907) and G.Wt = 0.0001 $L^{3.4027}$ (R^2 = 0.9915). The mean values for kc and kn were 0.0503 ± 0.0072 and 0.97 ± 0.088, respectively. Generally, it was observed that *F. commersonii* have a pattern of positive allometric growth as b values > 3 and the computed t-test was significant at 1% for females, males, and pooled samples in total and gutted weights. kc values reflected the body shape of *F. commersonii* as it is an extremely elongated, thin, whip-like body shape and kn reflected that the species lives in a good growth condition. Further biological research is required to understand *F. commersonii's* age, reproduction, feeding habits, and stock assessment in the Mediterranean Sea off Egypt.**

Keywords: Egyptian Mediterranean waters, *Fistularia commersonii*, Length-weight relationship, Fulton's condition factor, Relative weight condition factor

1. Introduction

Non-native species, primarily tropical and subtropical ones, have been invading the Mediterranean region during the past century. These species reach from the Red Sea via the Suez Canal and from the Atlantic Ocean via the Strait of Gibraltar. This phenomenon − known as 'Mediterranean tropicalization' − has become more frequent with the warming of sea waters (Andaloro and Rinaldi, 1998; Bianche and Morri, 2003).

The bluespotted cornetfish, *Fistularia commersonii* Rüppell, 1838 is now one of the most successful invaders of the Mediterranean Sea (Streftaris and Zenetos, 2006) and European waters (Roy et al., 2020). It was originally abundant in the Pacific and Indian Oceans (Fritzsche, 1976; Froese and Pauly, 2023). This species was first observed in the Eastern Mediterranean in January 2000 (Golani, 2000). Since then, it has rapidly expanded throughout the Mediterranean, notably in the eastern, central, and western basins (Bilecenoglu et al., 2002; Corsini

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et al., 2002; Azzurro et al., 2004; Ben Souissi et al., 2004; Karachle et al., 2004; Garibaldi and Orsi-Relini, 2008; Kara and Oudjane, 2008). In 2007 (Sanchez-Tocino et al., 2007), it made landfall in the Alboran Sea, the furthest reported migration of Lessepsian fish from its entrance location (CIESM, 2023).

The ecosystem is negatively impacted by this species' severe predation on a wide range of fish (mostly) and invertebrates species (Stergiou and Karpouzi, 2002; Kalogirou et al., 2007; Bariche et al., 2009; Katsanevakis et al., 2009). Abiotic factors appear to be the most important in structuring this species' Mediterranean distribution (Azzurro et al., 2012). *F. commersonii* was named one of the top 100 ‘worst invasive’ species in the Mediterranean Sea (Streftaris and Zenetos, 2006), and in the eastern half of the basin, even if it is a by catch, it is recognized as a highly common Lessepsian species with potential positive economic relevance (Golani et al., 2002; Zenetos et al., 2005; Carpentieri et al., 2008).

Though it is most frequently seen up to 100 cm, its maximum known size is 160 cm in length (Fritzsche and Schneider, 1995; Bariche and Kajajian, 2012). It inhabits shallow waters up to a depth of 128 m, either alone or in small groups (Lieske and Myers, 1995). Being a multispawner species, it demonstrated a lengthy reproductive season in the Levantine Basin, lasting between May and October (Bariche et al., 2013). The Eastern Mediterranean Basin is where the majority of data regarding bluespotted cornetfish populations in the Mediterranean region from, as this species has well established itself there. However, there have been few research conducted in the Western and Central Mediterranean basins, primarily concentrating on genetic and parasitological features (Golani et al., 2007; Merella et al., 2007, 2010; Sanna et al., 2011).

With the exception of morphometric study by Ragheb (2022) and the report of presentation of *F. commersonii* from Alexandria in 2001 (Halim and Rizkalla, 2011), not many studies have been done on this species in the Mediterranean waters of Egypt. In fisheries biology, length–weight relationships (LWR) are highly significant parameters that are frequently used to calculate condition indices, determine standing stock biomass, and explain several facets of the dynamics of fish populations (Bagenal and Tesch, 1978; Martin-Smith, 1996; Goncalves et al., 1997). So, the current study's goal is to ascertain the LWR and condition factors of *F. commersonii* from the Egyptian Mediterranean waters. It is hoped that such study will fill a gap in our knowledge on this fish, which begins to be appreciated as a marine food by some native people in Egyptian coastal cities and also provide useful information for fisheries scientist for more studies.

2. Materials and methods

A total of 746 bluespotted cornetfish, *F. commersonii* were randomly sampled each month from catch landed in Alexandria of the commercial trawling of fish from the Mediterranean Sea in Egypt, west of Alexandria, between El-Hamam and Sidi-Kirayr, at a depth of 40–60 m between October 2017 and March 2019.

In the laboratory, total length in cm, total and gutted weight in gram, and sex for each specimen of the *F. commersonii* were recorded.

Using the power equation, the LWR was computed as follows: $W = aL^b$, where L is the total length (cm), W is the total and gutted weight (g), and a and b are constants (Lagler, 1967). Using the formula $t = b-3/Sb$, where b is the regression coefficient and Sb is the standard error of b, Biley's t test was utilized to determine the value of b from the expected value of 3 (Snedecor and Cochran, 1967). Depending on the statistically significant difference and the constant b, one of three growth patterns will be identified: negative allometric growth ($b < 3$), positive allometric growth ($b > 3$), or isometric growth ($b = 3$).

The coefficient of condition, sometimes referred to as the Fulton's condition factor (kc), may be computed using the following formula: $kc = 100 \times W/L^3$, where L is the fish's length in total (cm) and W is its gutted weight (g) (Le Cren, 1951). Even if allometric growth is preferred, the condition factor (kc) is applied to be an approximation.

According to Le Cren (1951), the formula for calculating the relative weight condition factor (kn) is $kn = Wo/Wc$, where Wo denotes the total weight of fish seen and Wc is the total weight of fish computed using $Wc = aL^b$. The living circumstances of a species are determined by the relative weight condition factor (kn), which indicates if a fish is in excellent or terrible development condition based on whether it is greater than or equal to 1.

Microsoft Excel was used to conduct all statistical analyses for the study's male, female, and entire sample population.

3. Results

3.1. Length and weight composition

The *F. commersonii* sample weighs ~101 kg and consists of 746 specimens (334 females specimens, 386 males specimens, and 26 undetermined unsexed specimens). In the current study, *F. commersonii* length ranged from 24.1 to 107.5 cm total length (mean = 56.66 ± 15.740), the total body weight ranged from 5 to 1055 g (mean = 136.33 ± 135.418), and the gutted body weight varied from 4 to 856 g (mean = 124.03 ± 120.233) (Table 1). There were no female lengths smaller than 30.9 cm and no male lengths longer than 94 cm with females and males having mean total length of 58.96 ± 16.809 and 55.86 ± 14.059, respectively.

The number of females in the samples under study represented about 44.77 % which ranged in the total weight from 11.0 to 1055.0 g (mean = 159.75 ± 165.660) and ranged in the gutted weight from 9.0 to 856.0 g (mean = 142.26 ± 144.349). The number of males in the samples under study represented about 51.74 %, they ranged in the total weight from 5.0 to 605.0 g (mean = 122.22 ± 100.352) and ranged in the gutted weight from 4.0 to 557.0 g (mean = 113.83 ± 93.498) (Table 1). Unsexed specimens constituted 3.49 %.

3.2. Length–weight relationship

An examination of the LWR was conducted using total lengths (cm) and total and gutted weights (g), for females, males, and whole pooled samples were used to derive the LWR of *F. commersonii*. Given in Fig. 1 is the estimated LWR for *F. commersonii*, and Table 1 shows the LWR formulae. Given that these regression equations have greater coefficients of determination (R^2 = 0.99), they were the most appropriate for the relationship. These equations were: total body weight = 0.00008 $L^{3.4627}$ (R^2 = 0.9897), total body weight = 0.0001 $L^{3.4149}$ (R^2 = 0.9904), and total body weight = 0.0001 $L^{3.4314}$ (R^2 = 0.9907) for females, males, and whole pooled samples by using total weight (g), as well as, they were: gutted body weight = 0.0001 $L^{3.3944}$ (R^2 = 0.9916) for females, gutted body weight = 0.00009 $L^{3.4217}$ (R^2 = 0.9908) for males, and gutted body weight = 0.0001 $L^{3.4027}$ (R^2 = 0.9915) for whole pooled samples by using gutted weight (g).

In general, it was found that fish weight increased with length, with b values more than 3 (positive allometric growth) for females, males, and pooled samples in total and gutted weights and the t test of the allometric coefficient (b) was significant at 1 %, confirming a positive allometric growth. It was also found that there was also a significant difference at 1 % level between sexes for total weight (F = 10.47 at DF = 1; 717), but a nonsignificant difference was found between sexes for gutted weight (F = 3.29 at DF = 1; 717).

3.3. Fulton's condition factor (kc)

The most commonly used measure to assess fish species' health is Fulton's condition factor (kc). Even in cases when $b \neq 3.0$ and the growth is allometric, it is commonly used. Table 1 shows the Fulton's condition factor (kc) values (range; mean ± SD) of *F. commersonii* for females, males, and pooled samples based on gutted weight. The kc values of *F.*

Table 1. Total length (range and mean), total weight (range and mean), gutted weight (range and mean), length–weight relationship equations, Fulton's condition factor (kc), and relative weight condition factor (kn) for females, males, and whole pooled samples of Fistularia commersonii from the Egyptian Mediterranean waters (West Alexandria).

Fistularia commersonii	Females (N = 334; 53.4 kg)	Males (N = 386; 47.2 kg)	Pooled samples (N = 746; ≈101 kg)
Species composition parameters			
Total length (range) (cm)	30.9–107.5	24.1–94.0	24.1–107.5
TL (mean ± SD)	58.96 ± 16.809	55.86 ± 14.059	56.66 ± 15.740
T.Wt (range) (g)	11.0–1055.0	5.0–605.0	5.0–1055.0
T.Wt (mean ± SD)	159.75 ± 165.660	122.22 ± 100.352	136.33 ± 135.418
G.Wt (range) (g)	9.0–856.0	4.0–557.0	4.0–856.0
G.Wt (mean ± SD)	142.26 ± 144.349	113.83 ± 93.498	124.03 ± 120.233
Length–weight relationships			
By total weight	T.Wt = 8E-05 $L^{3.4627}$ (R^2 = 0.9897)	T.Wt = 0.0001 $L^{3.4149}$ (R^2 = 0.9904)	T.Wt = 1E-04 $L^{3.4314}$ (R^2 = 0.9907)
By gutted weight	G.Wt = 0.0001 $L^{3.3944}$ (R^2 = 0.9916)	G.Wt = 9E-05 $L^{3.4217}$ (R^2 = 0.9908)	G.Wt = 1E-04 $L^{3.4027}$ (R^2 = 0.9915)
Fulton's condition factor (kc)			
Range	0.0302–0.0753	0.0286–0.0680	0.0286–0.0753
kc (mean ± SD)	0.0501 ± 0.0072	0.0508 ± 0.0069	0.0503 ± 0.0072
Relative weight condition factor (kn)			
Range	0.76–1.32	0.68–1.44	0.63–1.35
kn (mean ± SD)	1.06 ± 0.103	1.04 ± 0.087	0.97 ± 0.088

TL, Total length; T.Wt, Total body weight; G.Wt, Gutted body weight.

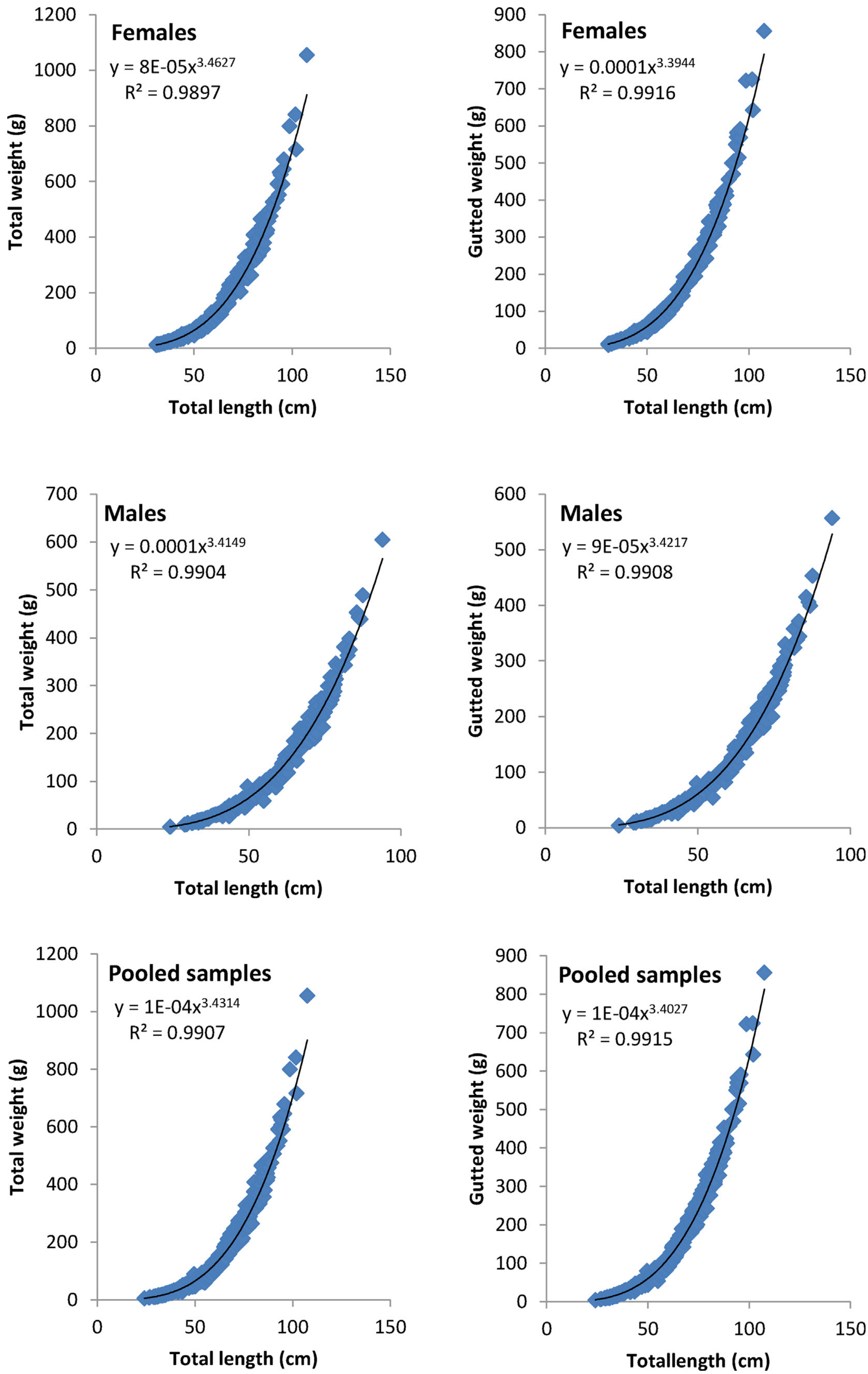

Fig. 1. Length–weight relationship for females, males, and whole population samples of Fistularia commersonii from the Egyptian Mediterranean waters (West Alexandria).

commersonii were determined to be less than 1.0. These values reflected the characteristics of body shape as extremely elongated, thin, whip-like body shape for the *F. commersonii*, as they ranged between 0.0286 and 0.0753 with a mean value of 0.0503 ± 0.0072 for pooled samples, ranging from 0.0302 to 0.0753 (mean = 0.0501 ± 0.0072) for females and 0.0286—0.0680 (mean = 0.0508 ± 0.0069) for males.

3.4. Relative weight condition factor (kn)

The relative weight condition factor (kn) values of *F. commersonii* based on total weight revealed a mean value close to 1.0 for females, males, and pooled samples (Table 1). As a result, this fish species live in favorable growing environments. The computed mean kn values were 1.06 ± 0.103, 1.04 ± 0.087, and 0.97 ± 0.088, respectively for females, males, and pooled samples with kn ranges of 0.76—1.32 for females, 0.68—1.44 for males and 0.63—1.35 for pooled samples. The spring season, on the other hand, has the lowest mean kn value, with kn equal to 0.94 for both males and females *F. commersonii* (Table 2).

4. Discussion

F. commersonii formed a new population on the Egyptian Mediterranean coast (Ragheb, 2022). This population ranged between 24.1 and 107.5 cm total length, with no females shorter than 30.9 cm total length and no males longer than 94 cm total length. However, the size range of *F. commersonii* in the Mediterranean varied from 5.0 cm standard length in the South Eastern Aegean Sea, Greece (Kalogirou et al., 2007) to 115.0—115.1 cm total length in the Central Mediterranean Sea and the Libya's Mediterranean coast at Benghazi (Castriota et al., 2014; Elbaraasi, 2014) (Table 3). In addition to variables including reproductive activity, food, and environmental conditions, differences in size can also be related to sex, fishing gear, season, and habitat (Le Cren, 1951; Froese, 2006), or they can be attributable to differences in the number of fish analyzed.

Table 2. Seasonal variation of relative weight condition factor (kn) for females and males of Fistularia commersonii from the Egyptian Mediterranean waters (West Alexandria).

Seasonal variations of relative weight condition factor (kn)				
Sex	Season	Number	Range	kn (mean ± SD)
Females	Winter	75	0.90—1.26	1.08 ± 0.067
	Spring	88	0.76—1.11	0.94 ± 0.075
	Summer	61	0.90—1.29	1.09 ± 0.080
	Autumn	110	0.97—1.32	1.12 ± 0.064
Males	Winter	106	0.78—1.19	1.05 ± 0.062
	Spring	79	0.68—1.44	0.94 ± 0.096
	Summer	58	0.88—1.21	1.03 ± 0.062
	Autumn	143	0.88—1.24	1.08 ± 0.061

LWR of fish is an essential biological tool for managing fish populations. The value of the LWR's exponent *b*, or isometric growth rate, equals 3 for an ideal fish (Allen, 1938). In the LWR, it is known that the constant *b* when calculated for the same species may differ if fishes were taken from different areas and from different seasons. Moreover, this variation is quite distinct between sexes and between fishes of different sexual maturity stages (Ricker, 1975). Table 3 makes it clear that the LWR's *b* values varied from 2.504 in Turkey's northeastern Mediterranean region (Ergüden et al., 2009) to 3.619 in Sicily's southern region (Vitale et al., 2016). Except for the b value of *F. commersonii* in the southern Sicily ($b = 3.619$) (Vitale et al., 2016), the projected range of 2.5—3.5 was observed for these *b* values throughout the various Mediterranean regions (Froese, 2006). Furthermore, two localities (Ergüden et al., 2009; Bílge et al., 2014) exhibit negative allometric growth, two localities (Pauly et al., 1998; Ergüden et al., 2022) exhibit isometric growth, and five localities (Kalogirou et al., 2007; Bariche and Kajajian, 2012; Castriota et al., 2014; Elbaraasi, 2014; Vitale et al., 2016) exhibit positive allometric growth. Meanwhile, the current study demonstrates a pattern of positive allometric growth for both genders and the whole sample of *F. commersonii*, corresponding to total and gutted weight. Numerous factors, including the physiological aspects of fish, growth phase, sex, sexual maturity, season, habitat, feeding rate, food, and health may be the cause of these differences in the estimated values of b (Le Cren, 1951; Froese et al., 2011; Mondol et al., 2017). The investigation's basic biological data, such as LWRs, can be helpful for future study on populations and stock assessments, which will then find use in these invasive species' sustainable management strategies.

Fish well being and the general health of populations in their habitats are assessed using condition parameters (Gomiero and Braga, 2005; Tsoumani et al., 2006). As indices, they demonstrate how biotic and abiotic elements interact and impact fish physiology (Blackwell et al., 2000). They also offer details on the environment's appropriateness and quality (Le Cren, 1951; Guidelli et al., 2011). Furthermore, in order to infer and forecast the causes of the species' well being and the conditions in which they live, it is best to research multiple condition factors (Ragheb, 2023). In the current study Fulton's condition factor (Kc) and relative weight condition factor (Kn) were calculated for female, male, and whole sample.

Table 3. Length—weight relationship parameters for Fistularia commersonii from different geographic regions.

References	Location	Number	Length type (cm)	Length range	Sex	Length—weight parameters		
						a	b	R^2
Fritzsche (1976)	Pacific Ocean	29	SL	17.8—86.5	—	—	—	—
Pauly et al. (1998)	Manila, Philippines	2	TL	78.0—104	—	0.00056	3	—
Golani (2000)	Mediterranean Sea, Israel	3	SL	26.8—51.6	—	—	—	—
Corsini et al. (2002)	Rhodes Island, Greece	37	SL	14.1—73.4	M + F	—	—	—
Kalogirou et al. (2007)	SE Aegean Sea, Greece	245	SL	5.0—108.0	M + F	0.000147	3.377	0.994
Ergüden et al. (2009)	NE Mediterranean, Turkey	12	TL	58.0—65.0	M + F	0.0112	2.504	0.981
Bariche and Kajajian (2012)	Eastern Mediterranean Sea	1073	TL	19.2—113.1	M + F	0.01066	3.406	0.989
Bílge et al. (2014)	Southern Aegean Sea, Turkey	48	TL	31.4—63.2	M + F	0.0118	2.727	0.992
Castriota et al. (2014)	Central Mediterranean Sea	60	TL	66.0—115.0	M + F	0.0001	3.372	0.857
Elbaraasi (2014)	Coast of Benghazi, Libya	190	TL	21.2—115.1	M + F	0.0013	3.32	0.98
Vitale et al. (2016)	South of Sicily	23	TL	69.0—104.0	M + F	0.0000009	3.619	—
Ergüden et al. (2022)	NE Mediterranean, Turkey	146	TL	23.0—108.1	M + F	0.0005	2.963	0.969
Current study	West of Alexandria, Egypt	746	TL	24.1—107.5	M + F	0.0001	3.4314	0.9907

F, female; M, male; TL, total length; SL, standard length.

It was found that the mean values of Kc are very similar to each other for females, males, and whole sample, and less than 1. Every population or the same population throughout several years may have slightly varied values, and kc more than 1 does not always indicate that the fish are in better condition. According to Ragheb (2023), fish shape and kc value are related, with each family having a unique range based on factors such shape, growth pattern, and *b* value. In the current work, the kc values reflected the body shape of *F. commersonii* as it is an extremely elongated, thin, whip-like body shape.

According to kn, the mean values for females, males, and whole sample showed that Kn was more than or equal to 0.97, a number that is closely related to 1. According to Jisr et al. (2018) and Ragheb (2023), they thus reside in favorable growth environments. As per the findings of Muchlisin et al. (2010) and Anderson and Neuman (1996), whereas kn values above 1.00 indicate low predator density or excess prey, kn values below 1.00 are suggestive of either high predator density or limited prey availability. Furthermore, Jisr et al. (2018) and Ragheb (2023) found that when the fish has access to enough food for optimal growth, kn is more than or equal to 1. As a result, we can conclude that Egyptian Mediterranean water is thought to be a good habitat for *F. commersonii* growth; however, it is also possible that spring is a poor time for the species to feed, or that the species has a physiological effect prior to the spawning season, which runs from May to October in the Eastern Mediterranean Basin, as noted by Bariche et al. (2013).

The current study is generally the first reference regarding LWRs and condition factors for *F. commersonii* inhabiting Egyptian waters. Fishery scientists and managers in the Mediterranean Sea might benefit from this study's basic information on the LWR and condition factors. Determining the population parameters of that species, which will contribute to near-future studies, is very important in terms of the ecological balance in the Mediterranean ecosystem of non-native species entering the Mediterranean waters. Consequently, in order to fill in the information gap, additional biological research is required to determine the age, reproduction, feeding, and stock assessment of the newly established *F. commersonii* in the Egyptian Mediterranean waters.

Declaration of Competing Interest

There are no conflicts of interest.

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